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To the problem of using an automated workplace by people with disabilities

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Introduction. Employees of the banking sector with health restrictions have negative experience of using internal software to interact with customers and perform their official duties. Many employees, for example, with hearing problems, would like to work in call centers, but do not have this opportunity due to the outdated software. The research objective is to analyze the priority tasks for the further development of software products, taking into account the existing health problems of employees.

Materials and Methods. One of the subsystems of the automated workplace (hereinafter referred to as the AWP) was selected the software, which allows the employee to interact directly with the clients of the given organization. The analysis used the method of expert evaluation by T. L. Saati with the assistance of one of the experts in the development of software for people with disabilities.

Results. Using the fundamental preference scale and expert opinion in the field of software development for people with disabilities, a priority matrix was built for each of the criteria (subtitles, simplified fonts, voice guidance, simplified and remote management) and platforms (IOS, Android, Windows OS), as well as a global priority matrix for all criteria and platforms.

Discussions and Conclusions. An expert assessment of several characteristics of the software of a commercial banking organization of the Russian Federation was carried out to identify the disadvantages of using the software by employees with disabilities. During the analysis, intermediate conclusions were made: the most demanded criterion for people with hearing problems is "Subtitle"; for people without the ability to leave the house — "Remote control"; for people with amputations or irreversible limb injuries — "Simplified control". The other parameters are not recommended for implementation.

Keywords: expert assessment, automated workplace, disability, commercial software, analytic hierarchy process.

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Introduction. The interaction of a client and an employee of a corporate organization is implemented through the complex software, which is designed to control access to the company's products and accelerate the processing of client requests. This is, for example, the customer relationship management system (CRM system) [1], which has proven itself well in the call center. There is also software for the cybersecurity department, where logging and listening of client or employee events takes place. All of the above, in contrast to the products used directly by customers, is poorly adapted for employees with physical disabilities (disability).

The analysis of some software characteristics is carried out to identify weaknesses in this problem. The assessment was carried out by the method of analyzing hierarchy of T. L. Saaty with the involvement of an expert on software for people with disabilities.

Materials and Methods. Expert evaluation by the Analytic Hierarchy Process (AHP) is the decomposition of the problem and the identification of the importance of criteria with the help of experts in this field. This method is well suited under the conditions of complete certainty and when there are many criteria [1].

According to expert opinion, the solution to the most acute problems with software for people with disabilities can be:

— simplified fonts for people with trouble seeing;
— voice guidance for visually impaired people;
— simplified management for people with amputations or irreversible limb injuries;
— subtitles for people with hearing problems;
— remote control for people without the ability to leave the house.

These problems can be implemented on the three most popular platforms for employee interaction with the application (channels): Android, iOS, Web browser. Initially, the problem is decomposed into criteria, and the decomposition is complete if each platform interacts with each criterion (Fig. 1).

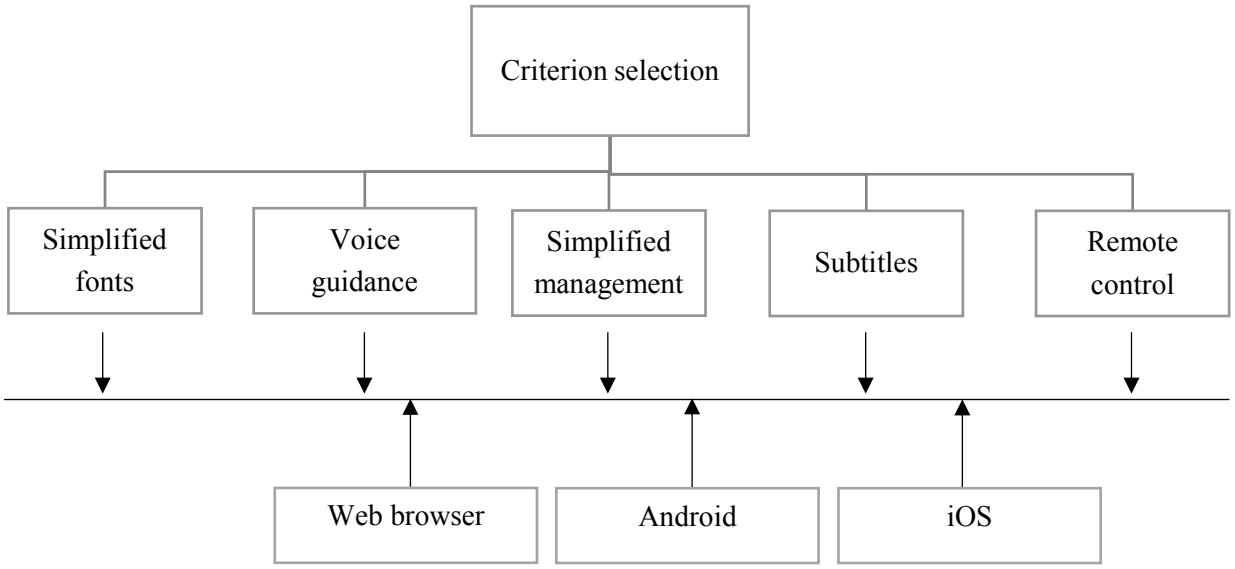

Fig. 1. Hierarchy of selection criteria for people with disabilities

To determine preferences for each platform and each problem, a pairwise comparison matrix is built. To do this, it is required to specify the evaluation scale (fundamental scale) [2–4], which has the form of an associative table (Table 1).

Table 1

Fundamental scale of preferences

Degree of preference	Definition
1	Both alternatives are the same in preference
2	Intermediate position between the same and average preference
3	One of the alternatives, according to the expert, is more preferable than the second
4	Intermediate position between average and moderately strong preference
5	One of the alternatives, according to the expert, is clearly preferable than the second
6	Intermediate position between moderately strong and very strong preference
7	One of the alternatives, according to the expert,

Degree of preference	Definition
	is much more preferable than the second
8	Intermediate position between a very strong and absolutely strong preference
9	One of the alternatives, according to the expert, is absolutely preferable than the second

Research Results. Priority[1] is calculated for each criterion [5]. To that end, a matrix is built (Table 2). Each criterion is compared to all the others on a scale from 1 to 9. Next, the product and sum for each criterion are found to analyze the local priority vector. The sum of local priorities, if calculated correctly, should be equal to one [6].

From the calculations, it can be concluded that the most preferred criterion is “Subtitles”. The next preferred criteria are “Simplified management” and “Remote control”.

Local priority vector $V_в$ is found from the formula:

$$V_в = \frac{\sqrt[n]{\prod_{i=1}^{n} K_i}}{\prod_{i=1}^{n} K_i}, \quad (1)$$

where n — number of criteria; K — criterion.

Table 2

Assessment of the criteria importance

Criterion	Matrix by criteria					Calculation parameters from formula (1)		
	Simplified fonts	Voice guidance	Simplified management	Subtitles	Remote control	Product	$\sqrt[5]{}$ of product	Local priority vector
Simplified fonts	1	5	1/4	1/2	1/3	0.20	0.72	0.12
Voice guidance	1/5	1	1/5	1/4	1/4	0.002	0.28	0.04
Simplified management	4	5	1	1/2	1/3	3.33	1.27	0.21
Subtitles	2	3	5	1	1	30	1.97	0.32
Remote control	3	2	3	1	1	18	1.78	0.29
Total	10.2	16	9.45	3.25	2.91	–	6.02	~ 1.000

Consistency index I shows the degree of consistency of the expert's estimates [7] and is calculated from the formulas:

$$I = \frac{|\alpha - n|}{n-1}, \quad (2)$$

$$\alpha = \sum_{i=1}^{n} V_i \cdot S_i, \quad (3)$$

where V — priority vector; S — sum of criteria; n — i-th criterion.

Consistency ratio R is determined from the formula:

$$R = \frac{I}{L} \cdot 100\ \%, \quad (4)$$

where L — random consistency.

[1] Krugova, I. V. Analiz kriteriev innovatsionnykh proektov PAO «Megafon» na osnove metoda analiza ierarkhii Saaty. In: Proc. III Sci.-Pract. All-Russian Conf. Tolyatti: Izd-vo Kachalin Aleksandr Vasil'evich; 2017. P. 297–302. (In Russ.)

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Random consistency is imperative values, which are given in Table 3 for matrices of different dimensions [8, 9]. In this case, the value is taken for a matrix of 5 criteria.

Table 3

Random consistency values for matrices of different orders

Matrix size	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

We calculate from formulas (2)–(4):

$$\alpha = 10.2 \cdot 0.12 + 16 \cdot 0.04 + 9.45 \cdot 0.21 + 3.25 \cdot 0.32 + 2.91 * 0.29 = 5.7324;$$

$$I = |5.7324 - 5| / (5 - 1) = 0.1831;$$

$$R = 0.1831 / 1.12 \cdot 100 = \sim 16\ \%.$$

Parameter R has a valid value (no more than 20 %).

At this stage, priority is determined for each of the criteria, and consistency of expert opinions is checked [10, 11]. The calculations are given in Tables 4–8.

Table 4

Priority matrix for the “Simplified fonts” criterion

Platform	Matrix for platforms			Calculation parameters		
	Web	Android	iOS	Product	$\sqrt[3]{}$ of product	Priority vector
Web	1	2	6	12	2.28	0.59
Android	1/2	1	4	2	1.25	0.32
iOS	1/6	1/4	1	0.04	0.34	0.08
Total	1.66	3.25	11	–	3.87	–

Using formulas (2)–(4) and Table 4, we calculate the consistency estimate [12]:

$$\alpha = 1.66 \cdot 0.59 + 3.25 \cdot 0.32 + 11 \cdot 0.08 = 2.8994;$$

$$I = |2.8994 - 3| / (3 - 1) = 0.0503;$$

$$R = 0.0503 / 0.58 \cdot 100 = 8.67\ \%.$$

The value of parameter R is valid

Table 5

Priority matrix for the “Voiced guidance” criterion

Platform	Matrix for platforms			Calculation parameters		
	Web	Android	iOS	Product	$\sqrt[3]{}$ of product	Priority vector
Web	1	1/3	2	0.66	0.87	0.23
Android	3	1	5	15	2.46	0.64
iOS	1/2	1/5	1	0.1	0.46	0.12
Total	4.5	1.53	8	–	3.79	–

Using the previous methodology and the data from Table 5, we calculate the consistency score:

$$\alpha = 4.5 \cdot 0.23 + 1.53 \cdot 0.64 + 8 \cdot 0.12 = 2.97;$$

$$I = |2.97 - 3| / (3 - 1) = 0.015;$$

$$R = 0.015 / 0.58 \cdot 100 = 2.58\ \%.$$

The value of parameter R is valid.

Table 6

Priority matrix for the “Simplified management” criterion

Platform	Matrix for platforms			Calculation parameters		
	Web	Android	iOS	Product	$\sqrt[3]{}$ of product	Priority vector
Web	1	1	2	2	1.259	0.4
Android	1	1	2	2	1.259	0.4
iOS	1/2	1/2	1	0.25	0.629	0.19
Total	2.5	2.5	5	–	3.147	–

We calculate the consistency score for simplified management according to the data from Table 6:

$$\alpha = 2.5 \cdot 0.4 + 2.5 \cdot 0.4 + 5.0 \cdot 0.2 = 3.0;$$

$$I = |2.95 – 3| / (3 – 1) = 0.025;$$

$$R = 0.025 / 0.58 \cdot 100 = 4.3\ \%.$$

And in this case, the value of parameter R is valid.

Table 7

Priority matrix for the “Subtitles” criterion

Platform	Matrix for platforms			Calculation parameters		
	Web	Android	iOS	Product	$\sqrt[3]{}$ of product	Priority vector
Web	1	1/5	1/2	0.1	0.46	0.13
Android	5	1	1	5	1.70	0.49
iOS	2	1	1	2	1.26	0.36
Total	8	2.2	2.5	–	3.42	–

Let us calculate the consistency score using the data from Table 7:

$$\alpha = 8 \cdot 0.13 + 2.2 \cdot 0.49 + 2.5 \cdot 0.36 = 3.018;$$

$$I = |3.018 – 3| / (3 – 1) = 0.009;$$

$$R = 0.009 / 0.58 \cdot 100 = 1.5\ \%.$$

The value of parameter R is valid.

Table 8

Priority matrix for the “Remote control” criterion

Platform	Matrix for platforms			Calculation parameters		
	Web	Android	iOS	Product	$\sqrt[3]{}$ of product	Priority vector
Web	1	1/2	1/6	0.083	0.436	0.101
Android	2	1	1/5	0.4	0.736	0.172
iOS	6	5	1	30	3.107	0.726
Total	9	6.5	1.36	–	4.279	–

We calculate the consistency score based on the data from Table 8:

$$\alpha = 9 \cdot 0.101 + 6.5 \cdot 0.172 + 1.36 \cdot 0.726 = 3.01436;$$

$$I = |3.01436 – 3| / (3 – 1) = 0.025;$$

$$R = 0.007 / 0.58 \cdot 100 = 1.2\ \%.$$

The value of parameter R is valid.

The initial data and the results of the calculation of global priorities are shown in Table 9.

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Table 9

Initial data and results of the calculation of global priorities

Platform	Matrix of global priorities by criteria					Global priority vector
	Simplified fonts	Voiced guidance	Simplified management	Subtitled	Remote control	
	0.12	0.04	0.21	0.32	0.29	
Web	0.59	0.23	0.4	0.13	0.101	0.23489
Android	0.32	0.64	0.4	0.49	0.172	0.35468
iOS	0.08	0.12	0.19	0.36	0.726	0.38004
Sum	–	–	–	–	–	~1

The calculation of global priority C of each platform relative to the criteria is performed from the formula [13]:

$$C = \sum_{ni}^{n} P_g \cdot P_l,$$

where n — i-th criterion; P_g — global priority of i-th criterion; P_l — relative priority of each platform for i-th criterion.

Calculate the global priority of all alternatives:

- for Web:(0.12 · 0.59) + (0.04 · 0.23) + (0.21 · 0.4) + (0.32 · 0.13) + (0.29 · 0.101) = 0.23489;
- for Android: (0.12 · 0.32) + (0.04 · 0.64) + (0.21 · 0.4) + (0.32 · 0.49) + (0.29 · 0.172) = 0.35468;
- for IOS: (0.12 · 0.08) + (0.04 · 0.12) + (0.21 · 0.19) + (0.32 · 0.36) + (0.29 · 0.726) = 0.38004.

Based on the calculation results, the priority is the iOS platform aimed at the development of functionality for people with disabilities, the Android platform is the closest to the priority [14].

Discussion and Conclusions. The conducted research using the hierarchy analysis method, considering the expert opinion, has shown that the most required criterion for people with hearing problems is “Subtitles” (index 0.32); for people without the ability to leave home — “Remote control” (index 0.29); for people with amputations or irreversible limb injuries — “Simplified management” (index 0.21). Other parameters are not recommended for implementation.

For the implementation of the “Subtitles” criterion, the required platform is Android OS (index 0.49). The iOS operating system has also turned out to be necessary enough (index 0.36). “Remote control” is most needed on the iOS platform (index 0.726). The “Simplified management” criterion equally requires Android and the Web version of the service (both indexes are 0.4). The global platform index for all criteria has shown the highest priority of iOS development.

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All authors have read and approved the final manuscript.